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(54) **HANDHELD VACUUM CLEANER**

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See application file for complete search history.

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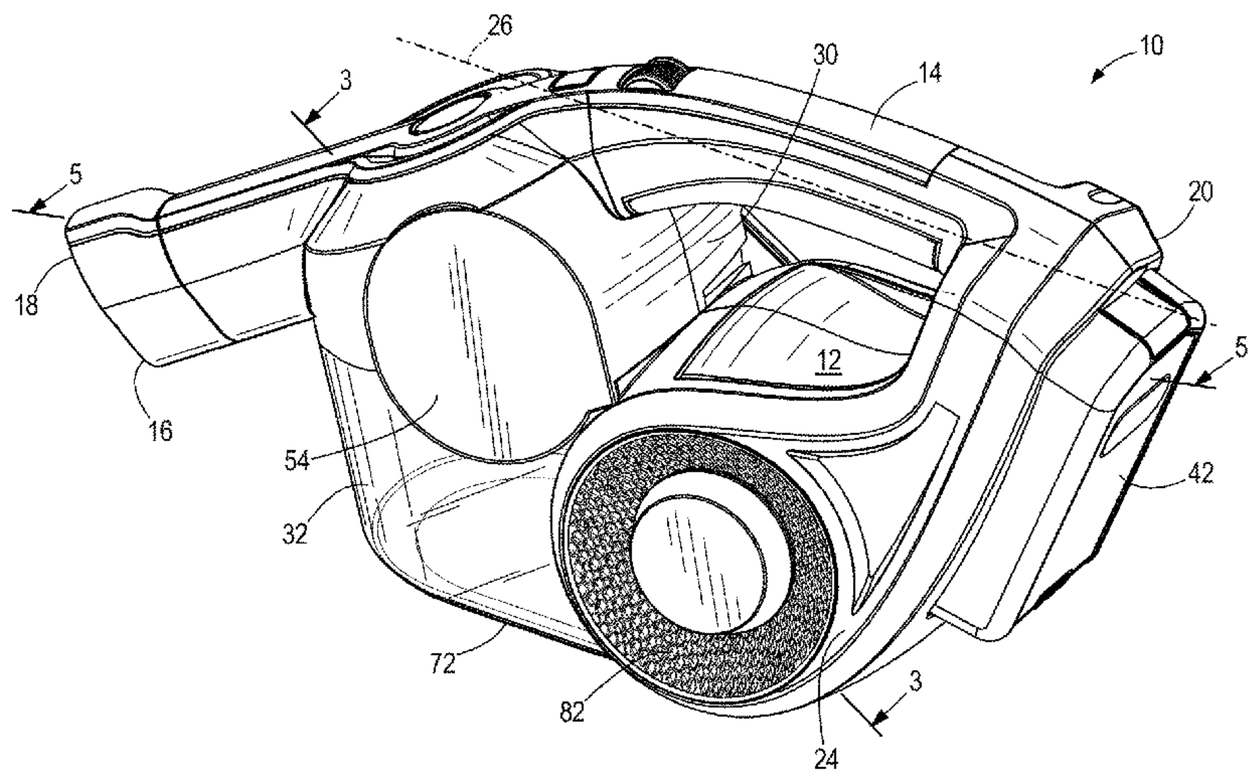
(57) **ABSTRACT**

A handheld vacuum cleaner including a housing having a front end, a back end, a first side, and a second side, the housing further including a handle along a handle axis. A suction nozzle is along a suction nozzle axis that extends in a direction from the front end toward the back end. The handheld vacuum further includes a suction source operable to generate an airflow through the vacuum cleaner from the suction nozzle through a cyclonic separator to a clean air exhaust. A battery that supplies power to the suction source and the battery is coupled to the housing adjacent an end of the handle. The handle extends between the battery and the cyclonic separator.

23 Claims, 5 Drawing Sheets



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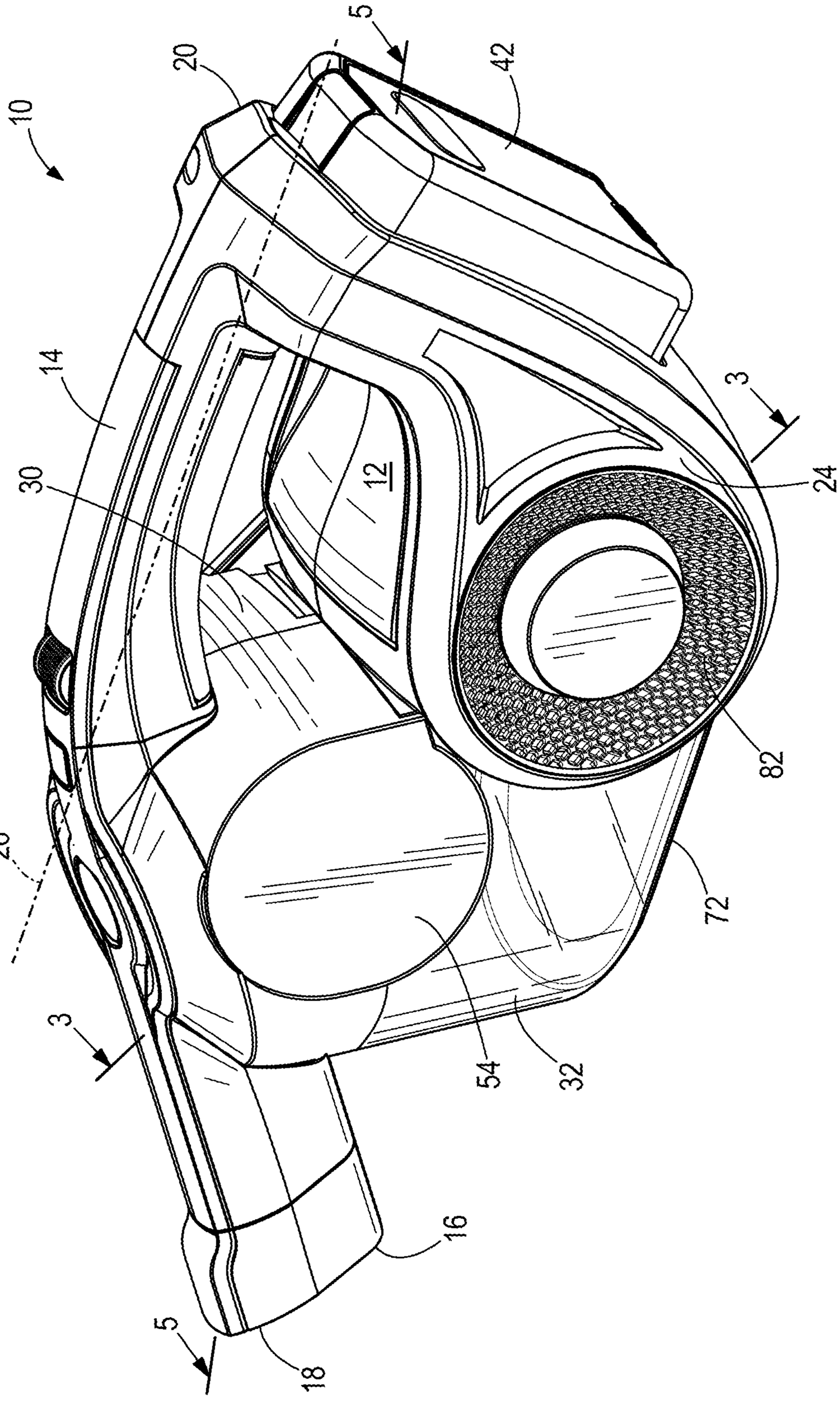


FIG. 1

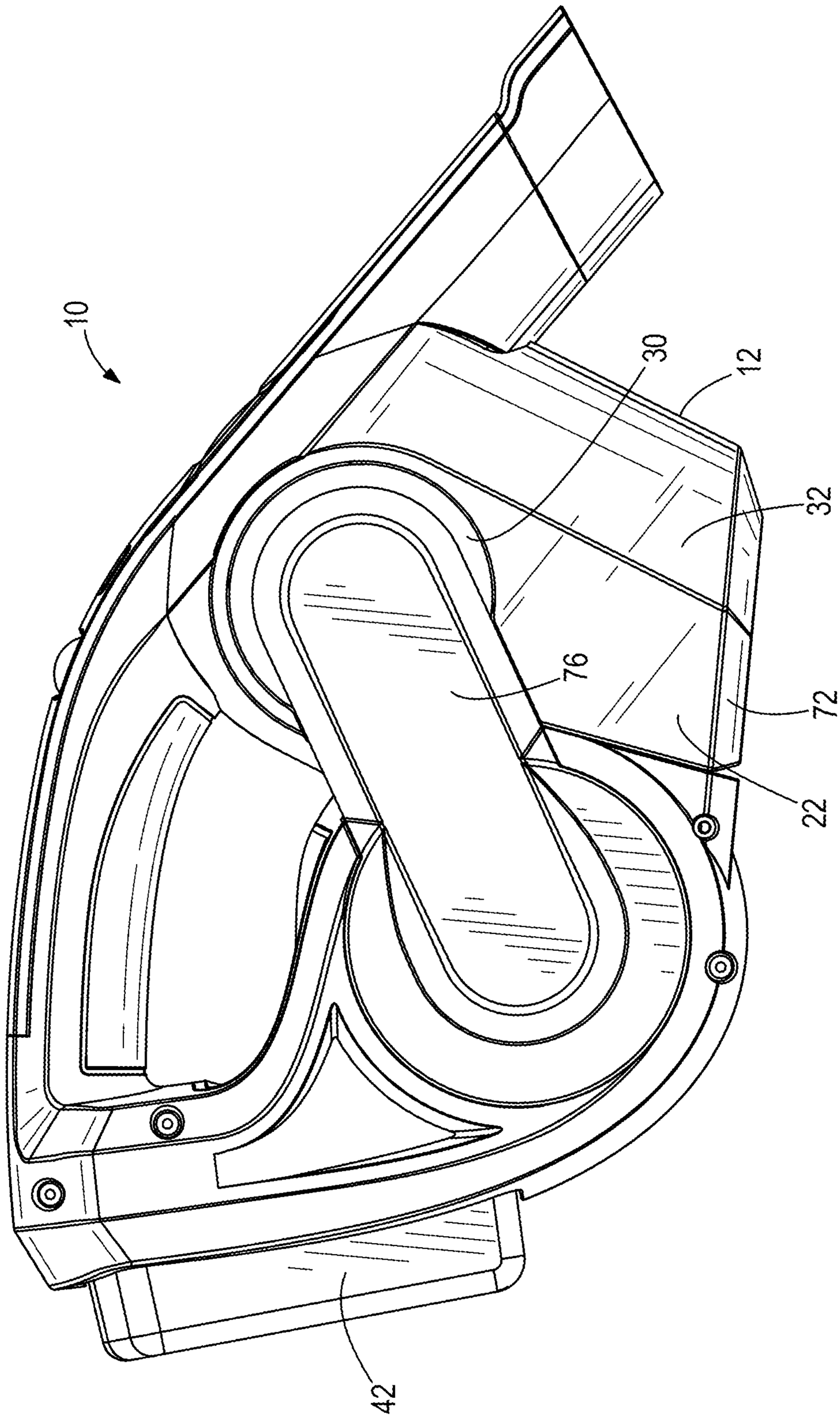
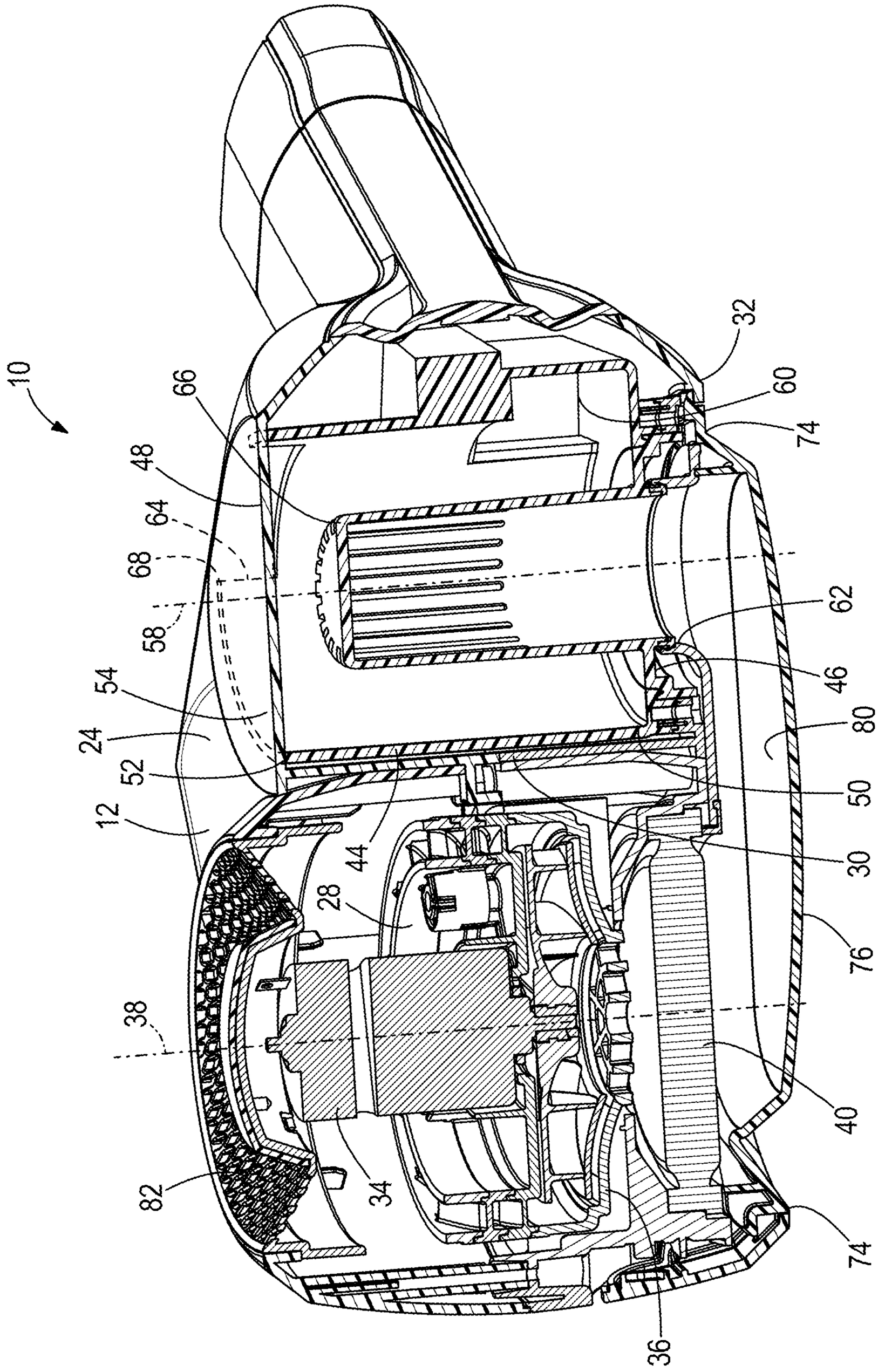


FIG. 2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60
32
74

FIG. 3

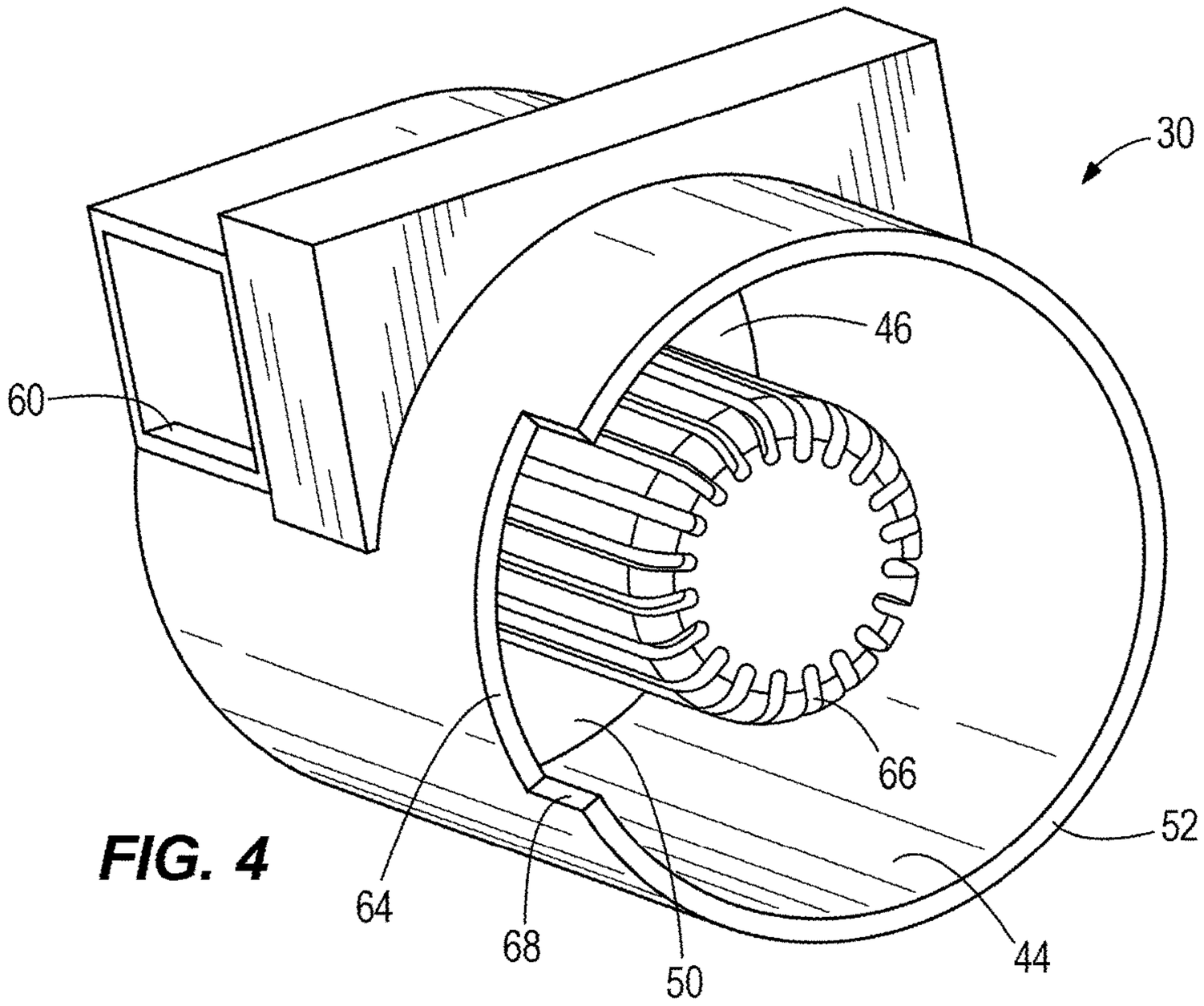
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FIG. 4

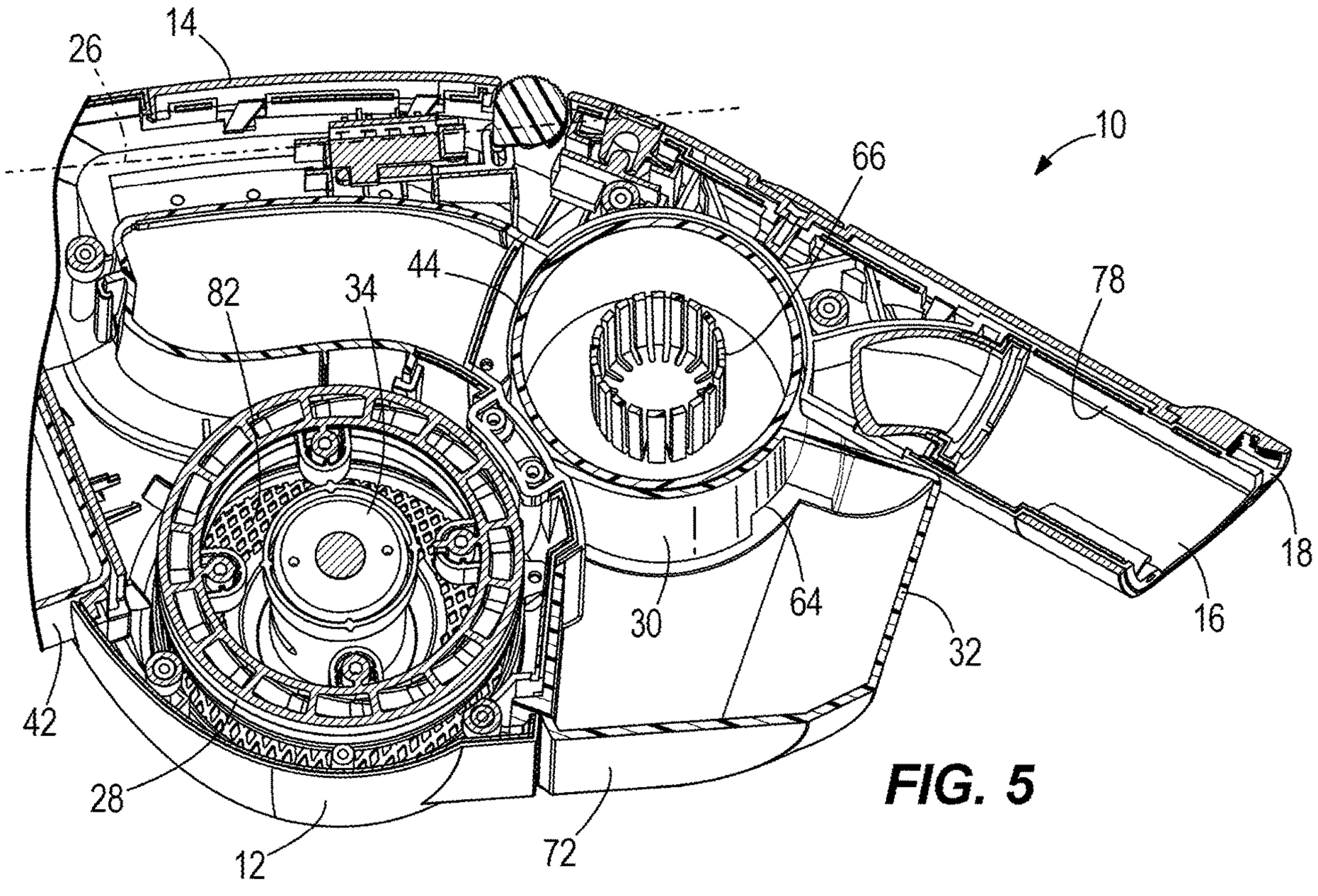
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FIG. 5

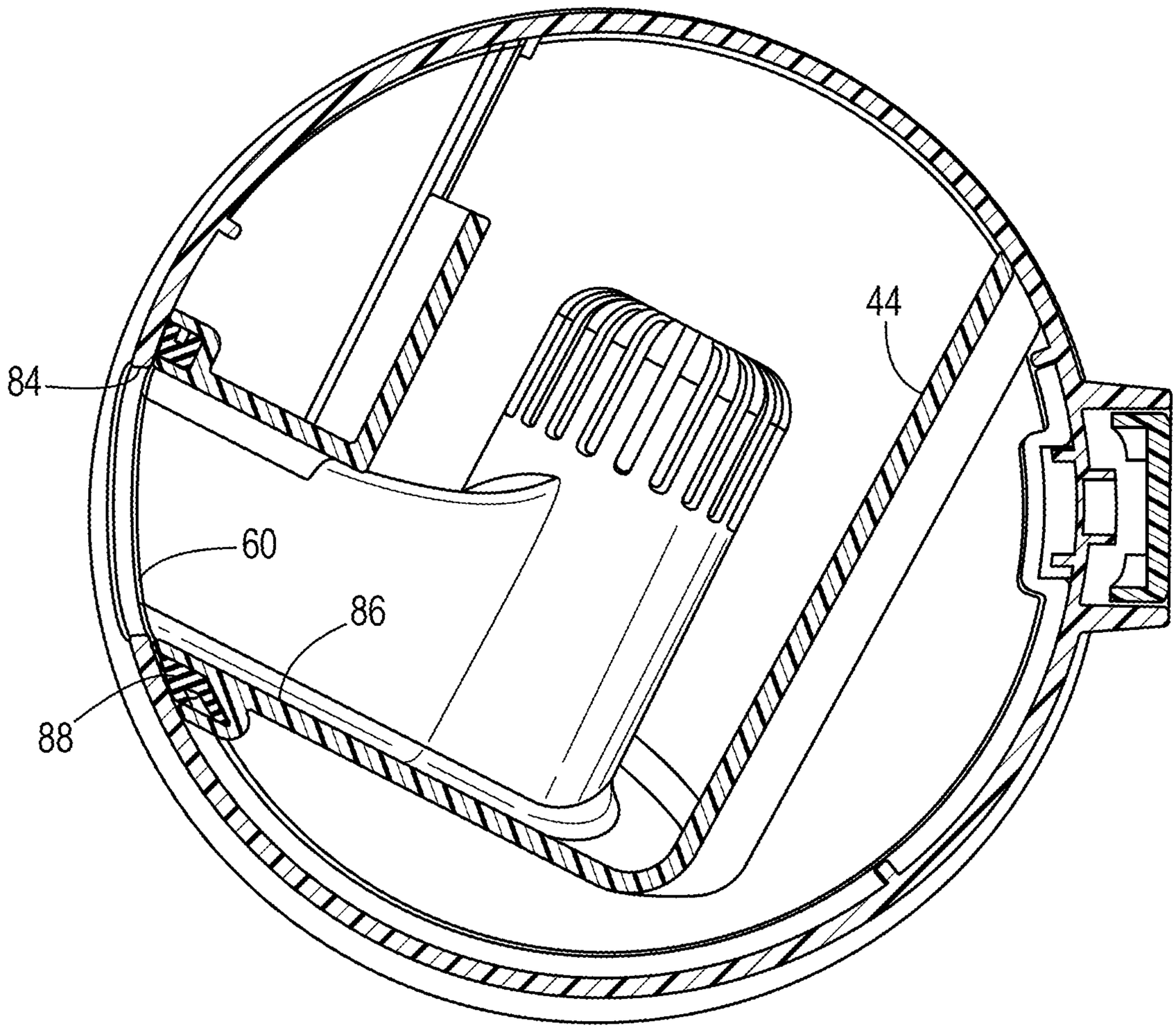

FIG. 6

HANDHELD VACUUM CLEANER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 16/177,739, filed Nov. 1, 2018, which issued as U.S. Pat. No. 10,980,379 on Apr. 20, 2021, which is a continuation of U.S. patent application Ser. No. 14/920,170, filed Oct. 22, 2015, which issued as U.S. Pat. No. 10,117,551 on Nov. 6, 2018, which claims priority to U.S. Provisional Patent Application No. 62/067,308, filed on Oct. 22, 2014, the entire contents all of which are hereby incorporated by reference.

BACKGROUND

The present invention relates to handheld vacuum cleaners, and more particularly, to cyclonic handheld vacuum cleaners.

SUMMARY

In one embodiment, the invention provides a handheld vacuum cleaner including a housing having a front end, a back end, a first side, and a second side, a suction nozzle, and a suction source operable to generate an airflow through vacuum cleaner from the suction nozzle through a cyclonic separator to a clean air exhaust. The cyclonic separator is operable to separate debris from the airflow. The cyclonic separator is located within the housing. The cyclonic separator includes a cylindrical wall having a first end and a second end, a first end wall located at the first end of the cylindrical wall, a dirty air inlet, a clean air outlet, a debris outlet adjacent the second end of the cylindrical wall, and a longitudinal axis along the cylindrical wall and the longitudinal axis of the cyclonic separator extends in a direction toward the first and second sides of the housing. The vacuum further includes a debris collection chamber located within the housing and in fluid communication with the debris outlet of the cyclonic separator. The housing further includes an aperture that extends through the first side. The first end wall of the cyclonic separator is removable through the aperture of the first side of the housing.

In another embodiment, the invention provides a handheld vacuum cleaner including a housing with a handle and a suction source operable to generate an airflow through the handheld vacuum cleaner from a suction nozzle through a cyclonic separator to a clean air exhaust. The cyclonic separator includes a cylindrical wall having a first end and a second end, a first end wall located at the first end of the cylindrical wall, a dirty air inlet, and a clean air outlet in the first end wall. The cyclonic separator is in a horizontal orientation, and the first end wall of the cyclonic separator is openable.

Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a handheld vacuum cleaner according to an embodiment of the invention.

FIG. **2** is an alternative perspective view of the vacuum cleaner of FIG. **1**.

FIG. **3** is a cross-sectional view of the vacuum cleaner of FIG. **1** taken along lines **3-3** shown in FIG. **1**.

FIG. **4** is a perspective view of a cyclonic separator of the vacuum cleaner of FIG. **1**.

FIG. **5** is an alternative cross-sectional view of the vacuum cleaner of FIG. **1** taken along lines **5-5** shown in FIG. **1**.

FIG. **6** is a cross-sectional view of a cyclonic separator of the vacuum cleaner.

Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

DETAILED DESCRIPTION

FIGS. **1** and **2** illustrate a handheld vacuum cleaner **10**. The vacuum cleaner **10** includes a housing **12**, a handle **14**, and a suction nozzle **16**. The housing **12** includes a front end **18**, a back end **20**, a first side **22**, and a second side **24**. The suction nozzle **16** is located at the front end **18** of the housing **12**. The handle **14** may be located at the top of the housing **12**, and in some embodiments, the handle **14** defines a longitudinal axis **26** that extends generally in a front-to-back direction along the housing **12**. Other handle arrangements may be configured as desired for the application.

Referring to FIGS. **3-5**, the vacuum cleaner **10** further includes a suction source **28**, a cyclonic separator **30**, and a dirt collection chamber **32**. The suction source **28** is located in the housing **12** and includes a motor **34** and a fan **36** operable to generate a suction airflow through the vacuum cleaner that is drawn from the suction nozzle **16** through the cyclonic separator **30** to a clean air exhaust **82**. The motor **34** includes a motor axis **38** (FIG. **3**) and the motor **34** is operable to rotate the fan **36** about the motor axis **38**. In the illustrated embodiment, the motor **34** and the fan **36** are orientated such that the motor axis **38** extends in a direction toward the first and second sides **22**, **24** of the housing **12** and therefore, the motor axis **38** is generally horizontal when the vacuum **10** is in use. Alternatively, the motor axis may extend in a generally front-to-back direction along the housing. A premotor filter **40** is also located in the housing **12** in a filter chamber on or adjacent the first side of the housing and the filter **40** filters the airflow before traveling through the motor **34** and fan **36**. The illustrated vacuum **10** includes a battery **42** that supplies power to the suction source **28** to operate the motor **34**. Alternatively or additionally, the vacuum may include a power cord for supplying power from a household electrical outlet (not shown).

The cyclonic separator **30** includes a cylindrical wall **44**, a first end wall **46**, and a second end wall **48**. The cylindrical wall **44** includes a first end **50** and a second end **52**. The first end wall **46** is located at the first end **50** of the cylindrical wall **44**. In one embodiment, the first end wall **46** is removably coupled to the cylindrical wall **44** so that the cyclonic separator **30** can be cleaned, which will be discussed in more detail below. The second end wall **48** is located at the second end **52** of the cylindrical wall **44**. As shown in the illustrated embodiment, the second end wall **48** is formed by a portion **54** of the second side **24** of the housing **12**. Optionally, an access door may be provided on the second side **24** of the housing for access to the inside of the cyclone. The cyclonic separator **30** includes a longitudinal axis **58** (FIG. **3**) that is along or surrounded by the cylindrical wall **44**. The axis **58** extends in a direction toward the first and second sides **22**, **24** of the housing **12**. In the

illustrated embodiment, the longitudinal axis **58** of the cyclonic separator **30** is approximately parallel to the motor axis **38** and therefore, the cyclonic separator **50** is also in a generally horizontal orientation.

As used in the present description and claims, a generally horizontal orientation means an orientation that is tilted over such that it is not vertical or upright. The generally horizontal orientation includes in various embodiments that are approximately parallel to the ground or floor, as well as orientations that are not parallel to the ground or floor but being generally more laying over than upright, i.e. being tilted more than about 45 degrees. In the illustrated embodiment, the suction source is adjacent the cyclonic separator in generally a side-by-side arrangement. In other embodiments (not shown), the motor axis may extend in a generally front-to-back direction along the housing such that the motor axis is generally perpendicular to the longitudinal axis of the cyclonic separator.

The cyclonic separator **30** further includes a dirty air inlet **60**, a clean air outlet **62**, and a debris outlet **64**. The dirty air inlet **60** is adjacent the first end **50** of the cylindrical wall **44** and extends through the cylindrical wall **44**. The clean air outlet **62** is also adjacent the first end **50** of the cylindrical wall **44**. More specifically, in the illustrated embodiment, the clean air outlet **62** is formed in the first end wall **46**. The illustrated cyclonic separator **30** includes a perforated tube **66** located within the cylindrical wall **44** that forms the clean air outlet **62**. The perforated tube **66** extends from the first end wall **46**. The perforated tube **70** may be perforated using holes, slots, screen, mesh, or other perforation. In the illustrated embodiment, an airflow passageway **80** (i.e., duct) (FIG. **3**) is positioned along the first side **22** of the housing **12** from the clean air outlet **62** to the filter chamber. In other words, the passageway **80** fluidly communicates the clean air outlet **62** with the premotor filter **40**. The debris outlet **64** is adjacent the second end **52** of the cylindrical wall **44** between the second end **52** of the wall **44** and the second end wall **48**. In the illustrated embodiment, the wall **44** includes a notch **68** that partially defines the debris outlet **64**.

The vacuum cleaner **10** further includes the dirt collection chamber **32** located within the housing **12** and in fluid communication with the debris outlet **64** of the cyclonic separator **30**. The dirt collection chamber **32** is generally located adjacent the cyclonic separator **30** and may be in front of the suction source **28**. In the illustrated embodiment, the dirt collection chamber **32** is adjacent the suction source, and may be positioned so that the dirt collection chamber **32** does not extend between the first end wall **46** and the first side **22**. Additionally, in the embodiment shown in FIG. **5**, the cyclone separator is positioned in the housing such that the debris collection chamber is bounded by the separator so that air does not circulate around the outside diameter of the cyclone. A dirt collector door **72** is removably coupled to the housing to facilitate emptying the debris collection chamber **32**.

Referring to the embodiment in FIGS. **2** and **3**, the housing **12** may further include an aperture **74** located on the first side **22** of the housing **12**. A door **76** is coupled to the first side **22** of the housing **12** to cover the aperture **74**. The door **76** can be opened by the user to permit access to the suction source **28** and premotor filter **40**. Optionally, the door **76** can be opened to permit access the cyclonic separator **30**. In other embodiments, a first door may be provided to access the premotor filter **40** and a second door may be provided to permit access to the cyclonic separator **30** and the aperture **74**. In the illustrated embodiment, at least a portion of the door **76** defines the duct **80** that provides fluid communication between the cyclonic separator **30** and the filter chamber and the suction source **28**.

In one embodiment, referring to FIGS. **4-6**, the housing **12** includes an inlet aperture **84** through the housing wall and the dirty air inlet **60** includes a passageway **86** between the inlet aperture **84** and the cylindrical wall **44** (FIG. **6**). The cyclonic separator **30** has a seal **88** positioned between the passageway **86** and the housing **12** around the inlet aperture **84** on an inside surface of the housing **12**. The seal **88** may be attached to the cyclonic separator **30** or the seal **88** may be attached to the wall of the housing **12**. In another embodiment, the seal **88** seals the interface between the passageway **86** and an inlet duct **78** that is between the suction nozzle **16** and the passageway **86**.

In operation, the power cord or battery **42** provides power to the motor **34** to rotate the fan **36** to generate a suction airflow that is drawn through the suction nozzle **16** along with debris. The airflow, entrained with debris, travels along the inlet duct **78** to the dirty air inlet **60** of the cyclonic separator **30**. The airflow and debris travel into the cylindrical wall **44** where the airflow and debris rotate about the longitudinal axis **58**. Rotation of the airflow and debris causes the debris to separate from the airflow and the debris is discharged over the cylindrical wall **44** through debris outlet **64**. The separated debris falls into the debris collection chamber **32**. The clean air travels through the perforated tube **66** forming the clean air outlet **62** of the cyclonic separator **30**. The clean airflow then travels through the duct **80** formed by the door **76** to the suction source **28**. The airflow travels through the premotor filter **40** before traveling through the suction source **28**. After traveling through the suction source **28**, the airflow is exhausted from the vacuum cleaner **10** through exhaust openings **82** in the second side **24** of the housing **12**.

After using the vacuum **10**, the user can open the dirt collector door **72** to empty the debris collection chamber **32**. After several uses, debris may collect on the perforated tube **66** and within the cylindrical wall **44**. If so, the user can open the door **76** and remove the first end wall **46** and perforated tube **66** from the cylindrical wall **44** through the aperture **74**. This allows the user to clean the perforated tube **66** and inside the wall **44**. Opening the door **76** also provides the user access to the premotor filter **40** and the passageway **80**, such that the user can clean or replace the premotor filter **40**.

Various features and advantages of the invention are set forth in the following claims.

What is claimed is:

1. A handheld vacuum cleaner comprising:

a housing having a front end, a back end, a top side, a bottom side, a first side, and a second side;

a handle, the handle including an end and a longitudinal axis that extends through the end of the handle;

a suction nozzle located at the front end of the housing, the suction nozzle extends in a direction from the front end toward the back end;

a cyclonic separator having a longitudinal axis;

a clean air exhaust;

a suction source located in the housing, the suction source including a motor and a fan, the motor operable to rotate the fan about a motor axis that extends in a direction from the first side toward the second side, the suction source operable to generate an airflow through the vacuum cleaner from the suction nozzle through the cyclonic separator to rotate the airflow about the longitudinal axis of the cyclonic separator and to the clean air exhaust; and

a battery that supplies power to the suction source, the battery located adjacent the end of the handle; and

wherein the battery extends between the end of the handle and the suction source.

2. The handheld vacuum cleaner of claim **1**, wherein the handle extends between the battery and the cyclonic separator.

3. The handheld vacuum cleaner of claim **1**, further comprising a handle aperture at least partially defined by the handle and the housing.

4. The handheld vacuum cleaner of claim **3**, wherein the handle aperture is between the handle and the suction source.

5. The handheld vacuum cleaner of claim **3**, wherein the suction source is between the aperture and the bottom side of the housing.

6. The handheld vacuum cleaner of claim **1**, wherein the cyclonic separator is between the suction nozzle at the front end and the suction source.

7. The handheld vacuum cleaner of claim **1**, wherein the battery is removably coupled to the housing.

8. The handheld vacuum cleaner of claim **1**, wherein the cyclonic separator is adjacent to the motor in a generally side-by-side arrangement.

9. The handheld vacuum cleaner of claim **1**, wherein the cyclonic separator includes a longitudinal axis that extends in a direction from the first side toward the second side.

10. The handheld vacuum cleaner of claim **1**, wherein the handle extends from the battery to the cyclonic separator around the suction source to define a handle aperture between the handle and the suction source.

11. The handheld vacuum cleaner of claim **1**, wherein the suction nozzle extends in a direction from the front end toward the back end that intersects the longitudinal axis of the handle.

12. A handheld vacuum cleaner comprising:

a housing having a front end, a back end, a top side, a bottom side, a first side, and a second side;

a handle, the handle including an end and a longitudinal axis that extends through the end of the handle;

a suction nozzle located at the front end of the housing, the suction nozzle extends in a direction from the front end toward the back end;

a cyclonic separator having a longitudinal axis;

a clean air exhaust;

a suction source located in the housing, the suction source including a motor and a fan, the motor operable to rotate the fan about a motor axis that extends in a direction from the first side toward the second side, the suction source operable to generate an airflow through the vacuum cleaner from the suction nozzle through the cyclonic separator to rotate the airflow about the longitudinal axis of the cyclonic separator and to the clean air exhaust;

a battery that supplies power to the suction source, the battery located adjacent the end of the handle; and

a handle aperture at least partially defined by the handle and the housing including the suction source.

13. The handheld vacuum cleaner of claim **12**, wherein the handle aperture is between the cyclonic separator and the battery.

14. The handheld vacuum cleaner of claim **13**, wherein the handle extends from the battery to the cyclonic separator around the suction source to define a handle aperture between the handle and the suction source.

15. The handheld vacuum cleaner of claim **13**, wherein the suction nozzle extends in a direction from the front end toward the back end that intersects the longitudinal axis of the handle.

16. The handheld vacuum cleaner of claim **13**, wherein the battery is removably coupled to the housing.

17. The handheld vacuum cleaner of claim **12**, wherein the handle aperture is between the handle and the suction source.

18. The handheld vacuum cleaner of claim **12**, wherein the suction source is between the handle aperture and the bottom side of the housing.

19. The handheld vacuum cleaner of claim **12**, wherein the cyclonic separator is between the suction nozzle at the front end and the suction source.

20. The handheld vacuum cleaner of claim **12**, wherein the suction source is between the handle aperture and the bottom side of the housing and adjacent the cyclonic separator and the battery.

21. The handheld vacuum cleaner of claim **12**, wherein the cyclonic separator is adjacent to the motor in a generally side-by-side arrangement.

22. The handheld vacuum cleaner of claim **12**, wherein the cyclonic separator includes a longitudinal axis that extends in a direction from the first side toward the second side.

23. The handheld vacuum cleaner of claim **12**, wherein the handle extends between the battery and the cyclonic separator.

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